

Students' Self-Reported Changes in Intercultural Knowledge and Competence Associated with Three Undergraduate Science Experiences

Carol Bender

University of Arizona

David Wright

University of Arizona

David Lopatto

Grinnell College

Introduction

Study abroad is the latest “must have” experience for undergraduate students according to an article in the November 4, 2007 *New York Times* (Pappano, 2007). University mission statements increasingly emphasize internationalization and employers increasingly seek graduates with experience in the global arena. This focus on international experience has led to the development of a variety of models for study abroad, including research abroad programs. To assess the value of an international research experience for undergraduates we examined the impact of two international programs on their respective participants and compared these to the gains achieved by students participating in research on their home campus.

Study Questions

This study is guided by four questions:

1. What were the primary motivators for students to participate in the summer programs included in this study?
2. What disciplinary gains did students report?
3. What personal gains did students report?
4. What changes in students' cultural awareness are associated with participation?

We answer these questions by assessing three factors Meyer-Lee and Evans classify as direct impacts on participants for study and research abroad programs: disciplinary knowledge, intercultural competence, and social growth (Meyer-Lee and Evans, 2007). We describe the gains reported by students in each program in each of these areas.

Description of the Programs

To assess the benefits of different types of international experiences, we surveyed students from two study abroad programs along with a comparison group of students doing research on the University of Arizona (UA) campus. The two study abroad programs were the Biomedical Research Abroad: Vistas Open (BRAVO!) Program and the Semester at Sea (SAS) Program. Subjects for the domestic comparison group were recruited from the UA Undergraduate Biology Research Program (UBRP). What follows is a brief description of each program.

The BRAVO! Program, based at UA and established in 1992, sends research-experienced undergraduates abroad to do research relating to their work on the UA campus. The BRAVO! Program's goals are to promote international understanding by enabling students in the sciences to participate in research abroad relating to the research they do at UA, and to advance collaborative projects involving UA biomedical and behavioral scientists and foreign scientists.

The program is highly individualized. BRAVO! students affiliate with a foreign scientist collaborating with their UA faculty mentor. The application process includes a research proposal which the applicant defends before a faculty committee. Students spend 10 weeks to a year at the foreign site. BRAVO! participants in this study spent 10 to 15 weeks of summer 2007 abroad. Because the student travels on his/her own and is typically the only U.S. student working in the foreign research group, this becomes a total immersion experience (for a more complete description of BRAVO! see Bender, 2004).

Semester at Sea (SAS) provides a shipboard academic program while navigating the globe and is co-sponsored by the Institute of Shipboard Education and the University of Virginia. The overall goal of the SAS program is to provide participants, both students and faculty, with global, comparative education—a form of international study that focuses on surveying the world's peoples, patterns, cultures, and traditions.

The SAS program takes an interdisciplinary approach to multicultural global education, enabling students to integrate their studies in art, the humanities, social sciences, science, mathematics, and engineering. Courses

are supplemented with field trips in foreign countries while the ship is in port. SAS students surveyed were all taking one or more of the four science or engineering courses offered during the 10-week summer 2007 voyage along the Pacific Coast of Central and South America. Each course included class-based research. The four courses were "Weather and Climate," "Climate Change," "Engineering Wonders from Meso-American to Modern Time in Latin America," and "Natural Hazards of Latin America." Students also took one credit hour courses in Spanish and in the history and culture of Latin America.

The Undergraduate Biology Research Program (UBRP), from which the subjects for the domestic comparison group were drawn, provides paid biologically-related research experience to UA undergraduates on their home campus. UBRP's goals are to teach students science by involving them in research, to allow students to make informed career decisions based on career related experience, to provide students a "home base" on campus, and to provide students the skills and knowledge to apply successfully for graduate and professional training. UBRP was established in 1988 and students are required to do full-time research for 12 weeks during the summer. (see Bender, Ward, & Wells, 1994 for a more complete description of UBRP).

UBRP students have international exposure without traveling abroad through interaction with foreign nationals working alongside them in their research groups. UA attracts visiting students and scholars from all over the world. Eleven of the 18 Summer 2007 UBRP students who took the post-test report working with from one to 10 foreign scientists in their research group. The countries represented included Russia, Indonesia, Mexico, China, Cameroon, Japan, the Czech Republic, the United Kingdom, Chile, Italy, Germany, Venezuela, South Korea, India, Iran, Brazil, Armenia, Argentina, Ecuador, and Pakistan. UBRP was included in the study to assess the similarities and differences between the domestic biology research experience and an international biology research experience.

Methodology

Respondents

Respondents were recruited from each of the three programs at different times but in each case before (or at the very beginning of) the experience. BRAVO! students were told about the study during the spring 2007 semester when they attended a BRAVO! program orientation. All 12 summer 2007 BRAVO! students participated and we have complete data for nine of these students. SAS students were recruited during the first week of their

voyage in June 2007. Twelve SAS students volunteered for the study and we have complete data from six. UBRP students were recruited during a program orientation in May 2007 and 21 students volunteered to participate as a domestic comparison group. We have complete data for 17 of them.

The BRAVO! and UBRP students were primarily biology majors while the SAS group represented a broader group of majors. Nine BRAVO! students were majoring in biology (biochemistry, molecular & cellular biology, ecology & evolutionary biology, physiology, or microbiology), two were majoring in speech & hearing sciences, and one was a psychology major. Similarly, majors of 17 members of the UBRP cohort included biochemistry, chemistry, ecology & evolutionary biology, molecular & cellular biology, and wildlife & fisheries; two were mathematics majors, one was a biosystems engineering major, and one was a chemical engineering major. The SAS cohort included one of each of the following majors: atmospheric sciences, biology, chemical engineering, civil engineering, communications, computer science, forensic science, international hotel management, mathematics education, nursing, psychology, and social work.

Class standing ranged from freshmen to seniors and was skewed towards upperclassmen. The BRAVO! cohort consisted of 25% sophomores, 42% juniors, and 33% seniors; the SAS cohort was 17% sophomores, 17% juniors and 66% seniors; and the UBRP cohort was 14% freshmen, 29% sophomores, 38% juniors and 19% seniors.

All BRAVO! and UBRP students were UA undergraduates. The SAS students were from 10 institutions including Delaware County Community College, Northern Arizona University, Millersville University, Richard Stockton College of New Jersey, The Ohio State University, Carleton College, Cabrillo College, St. Francis College, University of Pittsburgh (2), and Penn State University (2).

BRAVO! and UBRP students were engaged in research as their primary summer experience while the Semester at Sea students were enrolled in classes, at least one of which was a science or engineering class.

The BRAVO! and SAS students had a comparable amount of international experience going into the summer. Two SAS students and one BRAVO! student had no previous international experience.

The Surveys

Surveys were developed to assess the students' motivation for participating in their respective programs and to assess their self-reported learning and cultural gains. Items from these surveys were adapted from two sources—the

national Survey of Undergraduate Research Experiences (SURE) and a survey developed at Grinnell College that was intended to assess gains in study abroad programs. The SURE Survey was developed in 2002 by Dr. David Lopatto, in consultation with program directors of Howard Hughes Medical Institute-funded undergraduate research programs (for more information about the SURE survey, see Lopatto, 2004). Because items on this survey are used nationally to assess the learning gains of students in undergraduate research programs, we felt that these items would be appropriate to assess students' self-reported disciplinary learning across the three groups. Items from the Grinnell Survey of International Experience allowed students to self-report their gains in cultural understanding and their grasp of current events prior to and following the summer experience. It also included items that allowed students to assess their personal growth.

Procedure

Students participating in the three programs completed surveys at the beginning and at the conclusion of their experience. At the end of the summer, students in all three programs participated in focus groups to further reflect on their experience.

Results

While our sample sizes were small, students in all three programs self-reported gains in all the areas examined.

Motivation for Participation

One of the strongest motivations to participate for both BRAVO! and SAS students was the desire "to learn more about the world" followed by "personal growth," and "[a] desire to experience a different society and environment." Students in both BRAVO! and SAS responded affirmatively when asked if they "looked forward to their international experience."

BRAVO! students were more likely to report being influenced by a faculty mentor or advisor to have an international experience than were SAS respondents (100% vs 25% respectively). SAS respondents were more likely to report seeking to improve skills in a foreign language through the experience than were BRAVO! students (83% vs 45%).

Preparation for the International Experience

Students were asked to describe how they prepared for the international

experience. All of the BRAVO! students spoke to a native of the country they were to visit before traveling (this was part of their orientation) compared to one third of the SAS students. Four BRAVO! students (36%) followed the news in the countries they would visit before their experience while only two (17%) of the SAS students did. All of the BRAVO! and SAS students rated themselves as having below average knowledge of the country(ies) they would visit. Only one BRAVO! student took relevant courses (e.g. language, history, current events courses) prior to her experience, but 4 (33%) of the SAS students reported taking courses to prepare for the experience (some of these are the courses they were enrolled in on the voyage).

Expectations from the International Experience

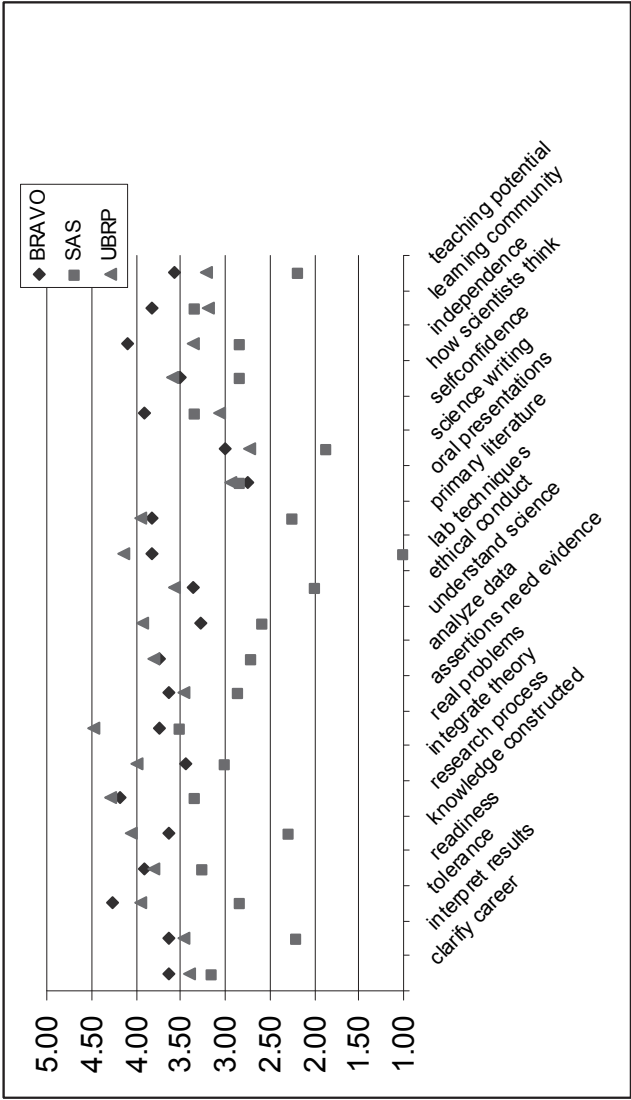
Fewer than half of the SAS students (44%) and the BRAVO! Students (45%) expected to become fluent in another language. All of the BRAVO! students expected to participate in formal culture learning (visiting museums, attending concerts, etc) and all but one BRAVO! student expected to participate in informal culture learning (meeting locals, living with a family, etc.). Eighty-three percent of SAS respondents expected to participate in formal culture learning and 75% expected to participate in informal culture learning. All of the BRAVO! students expected to further enhance and define their academic and career goals while abroad, compared to 75% of the SAS respondents. All BRAVO! and SAS respondents expected to advance their personal development with BRAVO! students reporting this as a greater expectation than SAS students.

Reported Learning Gains

Figure 1 shows the post-experience means for the SURE items for each of the programs, after eliminating missing or partial data. The figure includes data from 11 BRAVO! students, seven SAS students and 17 UBRP students. Students responded to twenty-one evaluative questions on specific learning gains on a scale of one to five where five indicates the greatest amount of learning.

SAS students self-reported comparable or greater learning gains than BRAVO! and UBRP students on three items: becoming part of a learning community, skill in oral presentations, and self-confidence. BRAVO! students self-reported greater gains than SAS or UBRP students in the following: clarifying career goals, skill in interpretation of results, tolerance for obstacles faced in the research process, readiness for more demanding research, understanding that assertions require supporting evidence, skill in science writing, self confidence, learning to work independently, and becoming part of a learning

Figure 1: Post-experience, self reported learning gains by program



community. UBRP students, most of whom were new to a research experience, self-reported greater gains than SAS and BRAVO! students in understanding how knowledge is constructed, understanding the research process, ability to integrate theory and practice, understanding how scientists work on real problems, ability to analyze data, understanding science, learning ethical conduct, learning lab techniques, understanding primary literature, skill in oral presentation, and understanding how scientists think.

Intercultural Competence Gains

Cultural gains were assessed in several ways. Survey questions asked students to describe current events taking place in the country (ies) they visited, they were asked about the relationships they developed with natives of the country (ies) they visited, and survey questions asked them to describe intercultural gains they had made. Students' responses in each of these areas are summarized next.

When asked to list and describe three current events in the country(ies) they visited, BRAVO! students provided more detailed responses than those provided by either the SAS group or the UBRP group. For example, the following responses to this question came from BRAVO! students' surveys:

An economic issue is the stagnation of wages. Since the early 1990s, the costs of living increased considerably for many reasons (the major ones are due to exponentially increasing rents and accommodation costs in Amsterdam), but the salaries did not increase. Several years ago, the average salary increase was below the inflation level, indicating that people lost money even if the costs of living had stayed constant.

During the summer the teachers went on strike due to the differences in the private and public education system. This caused problems for many travelers in the country. I heard of people that were not able to travel to Machu Picchu because the teachers had stopped the trains from running.

There's a debate over changing the health care system. More and more money is being put into the system, but people aren't seeing a change. Problems like long lists for operations and long delays on returning results are still a problem.

SAS students' responses tended to be a single word, such as "poverty" or "illiteracy." UBRP students' responses tended to elaborate a bit more and were similar to the response given by one UBRP student which was "Immigration bill failed to pass." Table 1 quantifies students' responses to the current events question.

When asked if they planned to keep in contact with people they met in the host country(ies), or in the case of UBRP students, the people in their research groups, BRAVO! and UBRP students indicated a greater likelihood to maintain contact than SAS students as indicated in Table 2.

Students were asked to reflect on what they accomplished or experienced through their international experience (and in the case of the domestic comparison

Table 1: Students' responses by program to current events during summer 2007

Program	Students listing no issues	Students listing 2 issues	Students listing 3 issues	Average number of words per issue for the group
BRAVO! (n=12)	1 (8%)	2 (17%)	9 (75%)	16.7
SAS (n=10)	1 (10%)	0	9 (90%)	2.6
UBRP (n=18)	3 (17%)	0	15 (83%)	4.1

Table 2: Likelihood of future contact with those in the host country (for UBRP, in the research group)

Item: I will keep in contact with people I met in the host country (ies)	No response	Definitely not true	Not true	Tends not to be true	Tends to be true	True	Definitely true
BRAVO! (n=12)	0	0	0	0	2 (17%)	4 (33%)	6 (50%)
SAS (n=10)	2 (20%)	1 (10%)	2 (20%)	2 (20%)	2 (20%)	0	1 (10%)
UBRP (n=18)	0	0	1 (5.5%)	1 (5.5%)	6 (33%)	4 (22%)	6 (33%)

group, what they think they would accomplish or experience by having an international experience). Responses by group are displayed in Table 3.

Respondents in BRAVO! and SAS also were asked to reflect on how their attitudes changed over the course of the summer. We wondered if the experience of working in a domestic research group could have the same impact on attitudes that working in a foreign research group might have. Consequently UBRP students were asked a slightly reworded version of each of these nine questions. The nine questions correspond to a six point Likert scale where one is “definitely not true,” 2 is “not true,” 3 is “tends not to be true,” 4 is “tends to be true,” 5 is “true” and 6 is “definitely true.” This scale forces students to choose a response that is negative or affirmative to varying degrees. We have complete data for 12 BRAVO! students, 10 SAS students, and 18 UBRP students on these nine questions. The mean response for each question is given below by group in the Table 4.

BRAVO! and SAS students' mean responses to questions dealing with changes in world view (items 1, 2 and 2a) are considerably higher than UBRP students' responses to the same questions.

Social growth: Students were asked to assess their self-confidence before and after the summer experience. Eight of the ten (80%) SAS students reported being more confident at the end of the experience, one (10%) reported no

Table 3: Advantages of international experience

Item	BRAVO! (n = 12)	SAS (n=10)	UBRP (n = 18)
Contributed to my undergraduate education	7 (58%)	7 (70%)	16 (89%)
Contributed to my major	4 (33%)	4 (40%)	12 (67%)
Helped me clarify my long term career goals	11 (92%)	5 (50%)	17 (94%)
Improved my skills in a foreign language	5 (42%)	10 (100%)	0
Learned more about the world	10 (83%)	9 (90%)	5 (28%)
Learned more about the place (politics, culture, environment, history) where I had my experience	12 (100%)	9 (90%)	0
Personal growth	12 (100%)	6 (60%)	10 (56%)
Experienced a different society and environment	12 (100%)	10 (100%)	0
Learned how to work and interact successfully with people in a culture other than my own	10 (83%)	6 (60%)	10 (56%)
Lived on my own	5 (42%)	0	3 (17%)
Other personal or professional reasons	2 (17%)	0	2 (11%)

Table 4: Respondents’ beliefs about how the experience affected their attitudes

	Mean Group Response to questions
Item 1: This experience caused me to think differently about the US and its place in the world	
BRAVO (n=12)	5.5
SAS (n=10)	4.8
UBRP (n=18)	3.0
Item 2: This international experience caused me to think about world/international issues differently	
BRAVO (n=12)	5.0
SAS (n=10)	4.5
Item 2a: This experience caused me to think about world/international issues differently	
UBRP (n=18)	3.0
Item 3: This international experience exceeded my expectations	
BRAVO	5.0
SAS	4.6
Item 3a: This experience exceeded my expectations.	
UBRP (n=18)	5.0

change in confidence level, and one (10%) SAS student failed to provide an answer to this question. Eleven (92%) BRAVO! students report feeling more confident after the experience and one (8%) reported feeling less confident. Among the UBRP group, 12 (67%) reported feeling more confident; three (17%) reported no change in confidence level; and three (17%) reported feeling less confident after the summer experience. They also were asked whether the experience made them understand themselves differently. In response to this question, BRAVO! students reported experiencing the greatest change in self-understanding, SAS students were close behind, and the UBRP students reported gains, but not to the degree reported by the BRAVO! and SAS groups (mean responses to this question were 4.9 for BRAVO! students, 4.7 for SAS students and 4.0 for UBRP students).

Discussion

This study suggests that while the three programs studied have different emphases and different goals, all three programs exceeded students' expectations and achieved the goal of increasing students' self-reported awareness of the world. The following sections discuss more specific conclusions we draw from our data, based on classifying the data into Meyers-Lee and Evans's three categories of direct impact of international experience—gains in disciplinary knowledge, intercultural competence, and social growth.

Gains in disciplinary knowledge

Results from questions taken from the SURE survey confirm that using self-report measures, BRAVO! students and UBRP students achieved similar gains through their research experiences. While there is some variance among groups, they are, on balance, very comparable, and they are comparable to the scientific gains self-reported by 1,300 students at other US institutions who participated in the summer 2007 SURE Survey. It makes sense that BRAVO! students, by virtue of their individualized research experience in a foreign research group, would report greater gains than SAS and UBRP students in clarifying career goals, skill in interpretation of results, tolerance for obstacles faced in the research process, readiness for more demanding research, understanding that assertions require supporting evidence, skill in science writing, self-confidence, independence and becoming part of a learning community. BRAVO! students must be research-experienced *before* applying to the program and their integration into foreign labs likely leads to their feeling of being part of a learning community. Because they need to negotiate a foreign

culture on their own, rather than as part of a group, they likely develop greater independence than students in a group program. BRAVO! students frequently are asked to edit the papers of the non-native English speakers with whom they work, resulting in increased confidence in their scientific writing ability. It is not surprising that UBRP students, newly exposed to doing research, would report greater gains in how knowledge is constructed, understanding the research process, integrating theory and practice, understanding how scientists work on real problems, analyzing data, understanding science, learning ethical conduct, and understanding how scientists think. Research-experienced BRAVO! students would have an understanding of these things by virtue of their prior experience but for most UBRP students, the summer experience provided the first exposure to the research process.

The SAS students self-reported fewer disciplinary gains perhaps because the SAS experience was classroom-based rather than laboratory-based and because many of the SAS students responding to the questionnaire including these items were not science majors.

UBRP students were most likely to report that the summer experience abroad would contribute to their undergraduate education (89%), followed by SAS students (70%) and BRAVO! students (58%). Sixty-seven percent of UBRP students said their experience contributed to their major, while 40% of SAS students and 33% of BRAVO students reported this. It can be argued that BRAVO! students could have chosen a summer experience more directly in line with their undergraduate majors, but in choosing an international experience were looking for something beyond fulfilling degree requirements. BRAVO! and UBRP students saw their summer experience as clarifying their career goals (92% and 94% respectively) to a greater extent than SAS students did (50%). This may be because the techniques and scientific skills BRAVO! and UBRP students acquire through doing research can apply directly to careers they are likely to pursue while SAS students' experience would apply to what they might do in the future, but in a more general way.

BRAVO! students reported fewer gains in language learning, relative to SAS students. This is not surprising because language training is not a formal part of BRAVO!. In contrast, all of the SAS students reported gains in language proficiency.

Social growth

Students in all three programs reported significant gains in personal growth and in learning how to work and interact successfully with people in a

culture different from their own. As one might expect this is true to a greater extent for the BRAVO! and SAS students than for the UBRP students whose experience took place on their home campus.

Intercultural competence

There is a clear difference between the BRAVO! and SAS students and the UBRP students in reporting gains in awareness and learning about the world. Studying or doing research abroad positions students to understand the world differently (83% of BRAVO! students reported learning more about the world, while 90% of SAS students report this, and only 28% of UBRP students affirmed this from their domestic summer experience).

From Table 1 we see that of the three groups, BRAVO! students' responses to questions about current events suggest both a greater awareness of and a greater excitement about current events than responses given by the SAS or UBRP students.

Table 2 suggests that BRAVO! and UBRP students' involvement in research teams lends itself to establishment of long-term bonds, while the SAS classroom experience may not be as conducive to development of long-term relationships with foreign nationals.

Culturally, much of what we were able to observe through this study confirms what is intuitive. Students who participate in an immersion experience such as BRAVO! tend to report greater understanding of issues specific to the country they visited, and tend to form relationships with individuals in the host country that they expect will be long-lasting. UBRP students, working in domestic research groups populated in part with foreign nationals, develop bonds with these individuals through a shared interest in scientific problem solving. Students participating in an international experience that is comparative, such as SAS, have a broader experience allowing them to develop a broader academic view of issues, albeit in less depth.

In the words of an SAS student, "I really enjoyed being able to learn things in the classroom relevant to my major and then being able to go and visit the sites talked about in class. It was as if the world was my classroom."

We surmise that SAS students observe the countries they visit while BRAVO! students experience life as it is lived in the host countries. Both types of experiences play an important role in providing undergraduates an informed world-view. Because science is international, UBRP students tend to develop an indirect appreciation for different cultures through their interactions with foreign students and scientists in research groups on their home campus.

Limitations

This study provides documentation of the self-reported changes in students participating in international science experiences. A number of limitations should be mentioned. First, students self-selected into the programs. No effort was made to match students on the basis of anything other than their interest in an international experience. It is likely that students with different academic backgrounds, different life experiences, and different career goals will gravitate to different types of programs. Second, the sample sizes are too small to provide statistical significance. Because of this, the study should be considered a pilot, suggesting areas for further investigation. Third, the data are all self-report data and thus highly subjective. In such a study it is difficult to imagine a means of collecting objective data. Students' perceptions of their growth, however, should not be discounted.

Conclusion

Academic international experiences for undergraduates are offered through a wide range of programs. Students participating in an on-campus science research program such as UBRP can also gain international perspectives because of their interaction with foreign nationals in their research groups. This can be an important stimulus to enter programs such as SAS or BRAVO!. The emphasis, types of experiences offered, and potential outcomes from these programs can be quite different. We believe it is important for students to be aware of these factors in choosing a study abroad program. They can be guided by study abroad program advisors who know students' needs and are well versed in what different opportunities offer. As we discovered while comparing the experiences of students in two international programs, BRAVO! and SAS, and the domestic UBRP program, students' self-reported learning and cultural gains were often different but all were valuable. In general,

- Students interested in language acquisition and in a broad comparative introduction to issues in several countries would best be served by a program like SAS.
- Students interested in developing an in-depth understanding of a culture and in honing their research skills may be better served in an immersion type of program such as BRAVO!
- Students less sure of being able to manage on their own in a foreign culture might first choose a program such as SAS, where they do not have to negotiate their living situation in a foreign country. Such an introduction might prepare them for a second experience that would require more independence such as the BRAVO! Program.

In short, this paper has described the impact of three of the many programs through which undergraduate students can develop into culturally sophisticated, productive citizens of the world.

References

- Bender, Carol (2004). "Biomedical research abroad: Vistas open (BRAVO!): A program to internationalize the undergraduate science curriculum. *In: Reinventing the Undergraduate Experience: Successful Models Supported by NSF's AIRE/RAIRE Program.*" J. Stocks and L. Kauffman (eds). Council on Undergraduate Research. Available on line at: http://www.cur.org/publications/AIRE_RAIRE/arizona.asp
- Bender, Carol, Ward, Samuel, Wells, Michael A (1994). "Improving undergraduate biology education at a large research university." *Molecular Biology of the Cell*, 5:129–134.
- Lopatto, David (2004). "Survey of undergraduate research experiences (SURE): First findings." *Cell Biology Education* 3, 270–277.
- Meyer-Lee, Elaine, Evans, Joy (2007). "Areas of study in outcomes assessment." *In: A Guide to Outcomes Assessment in Education Abroad.* M.C. Bolen (ed.). Forum on Education Abroad. 61–70.
- Koh Cin, H and Bhandari, R (2006). Open Doors 2006: Report on International Education Exchange. New York: Institute of International Education, 18–19.
- Pappano, Laura (November 4, 2007). "The foreign legions." *The New York Times: Education Life*, 28–29.

Acknowledgements

This project was funded in part by the UA Office of International Affairs and by a grant from the Howard Hughes Medical Institute to the University of Arizona (HHMI 52003749). We are grateful to the Institute for Shipboard Education, which graciously provided accommodations for the authors (Bender and Wright) on the Semester at Sea ship, and gave us access to the SAS students and faculty. Sara Olsen and Liz Zavodsky helped in the initial development of our questionnaires. We appreciate Ms. Zavodsky's efforts to recruit SAS students to the project. Finally, we thank Michael Wagenheim who greatly facilitated data collection by making our survey instruments web-based.

